MITOTIC DIVISION OF BINUCLEATE CELLS.

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Attention has been called to the presence of binucleate cells in the follicular epithelium of insects by several observers (Korschelt, '87, Preusse, '95, De Bruyne, '97, Gross, 01, et al.). In *Notonecta*, binucleate cells are characteristic of the follicular epithelium and also of the tissues lining the sperm duct and investing the spermatogonial cysts. These binucleate cells undergo normal mitotic division, both nuclei being involved. As a usual rule, both nuclei pass through the stages of division synchronously, though rarely one finds one nucleus in advance of the other. (Fig. 11, upper cell.)

In the resting stage (Fig. 1), each nucleus is exactly similar to the single nucleus of a spermatogonial or oögonial cell, a conspicuous karyosphere being present (Browne, '13). In the prophase, the two nuclei remain distinct and thick chromatin strands are present in each nucleus (Fig. 2, upper cell, Fig. 3). When the nuclear wall breaks down in the late prophase (Fig. 4), the two nuclei may undergo a certain amount of fusion, or they may remain entirely distinct and this is true also of the metaphase. In some cases, two distinct plates may be seen in polar view (Fig. 5) or two distinct spindles in side view (Fig. 6); in fact, the two spindles may be so independent as to lie in different planes, so that one is seen in side view and the other in polar view (Fig, 7). In other cases, the two spindles become so intimately combined as to appear as one giant spindle. In polar view a perfect equatorial plate is seen, but there are *twice as many chromosomes present as the diploid number for the species.* Each chromosome of the spermatogonial or oögonial metaphase is represented by two exactly similar chromosomes in these binuclear plates, as may be seen by comparing Fig. 8 from an oögonial cell of *Notonecta indica*, with Fig. 2 (lower cell) from a follicle cell of the same species. In the oögonial cell, there are 6 large, 4 small and 16 intermediate sized chromosomes, in

the binucleate follicle cell there are 12 large, 8 small and 32 intermediate ones. Similar double chromosome plates have been found in the follicle cells of other insects, *e.g.*, *Anasa* (Wilson, '06) and are probably likewise due to the division of a binucleate cell.

In the anaphase (Fig. 9), the two sets of chromosomes cannot be distinguished, and the two spindles appear always to be fused. It is difficult to tell exactly what happens in the telophase. It would seem that a membrane formed around the group of chromosomes at each pole, (Fig. 10), each daughter nucleus becoming elongated and that it later separated off into two nuclei (Figs. 11 and 12). It seems entirely possible that in such a separation into two nuclei, which would resemble a nuclear amitosis, the chromosome content might be so distributed that each nucleus would maintain the chromosome constitution characteristic of the species. It is possible that the separation into two nuclei occurs only in those cases where the original sister nuclei did not become entirely fused and that when they are fused, each daughter nucleus remains as an abnormally large nucleus, really double in nature. It is evident, however, from the series of figures that two binucleate cells may arise by the mitotic division of a binucleate cell.

Although the binucleate cells of the follicular epithelium have been believed by some observers (Preusse, '95, De Bruyne, '97, Gross, '01), to arise by an amitotic division, I have found no evidence of such an origin, and would believe it probable that they arise by the failure of cell division after a nuclear division by mitosis. Macklin ('16) has described a process of amitotic nuclear division in his study of binucleate cells in living tissue, but the figures he gives might also be interpreted as the last stages in the mitotic division of a binucleate cell as described above. If binucleate cells do arise as Macklin believes and his interpretation of them as potentially mononuclear, is correct, there must be two types of binucleate cells. In one type, each of the two nuclei has a complete set of chromosomes, as described above. In the other type, the two nuclei taken together have a complete set of chromosomes. Macklin was, however, unfortunately unable to verify his assumption as to the chromosome

constitution of his binucleate cells. Binucleate cells, arising by the suppression of cell division after nuclear division by mitosis have also been produced experimentally in the cleavage cells of *Crepidula* (Conklin, '12). The two nuclei may divide mitotically and entirely independently although synchronously; in these cases, however, two mononucleate cells are usually produced from the original binucleate cell.

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EXPLANATION OF PLATE I.

Fig. 1 from the sperm duct of *Notonecta shooterii;* Fig. 8 from oögonial cell of *N. indica*, other figures from follicle cells of *N. indica.*

FIG. 1. Binucleate cells from sperm duct of *N. shooterii*, resting stage.

FIG. 2. Upper cell, prophase. Lower cell, metaphase showing a perfect double chromosome group, 52 chromosomes.

FIG. 3. Prophase.

FIG. 4. Late prophase.

FIG. 5. Metaphase, polar view, two plates separate.

FIG. 6. Metaphase, side view, two plates separate.

FIG. 7. Metaphase, two spindles in different planes.

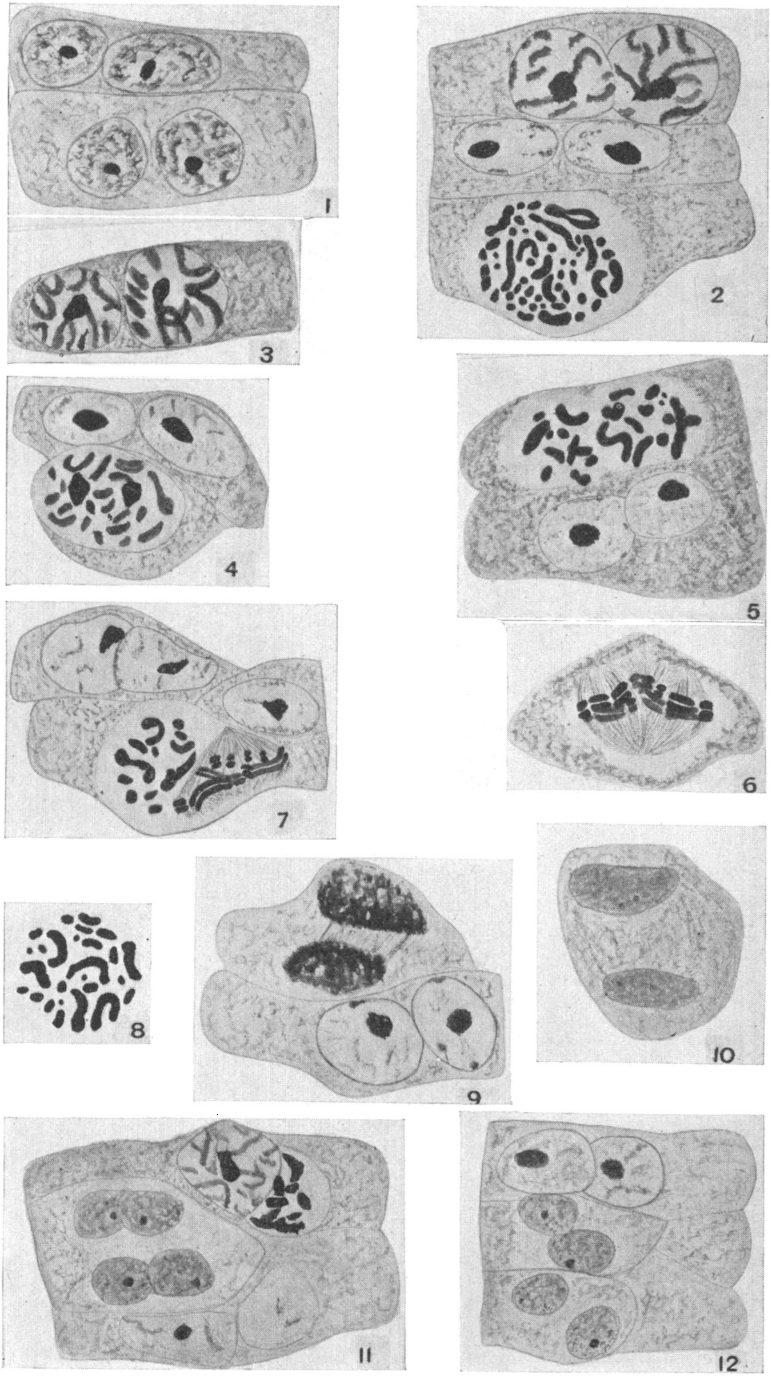
FIG. 8. Metaphase of oögonial cell of *N. indica*, showing 26 chromosomes.

FIG. 9. Anaphase.

FIG. 10. Telophase.

FIG. 11. Lower cell, telophase, sister plates dividing into two. Upper cell one nucleus in prophase, one in metaphase.

FIG. 12. Late telophase showing two daughter binucleate cells.



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